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British Standards Institution
Reports

No. 90—1919.

British Engineering Standards Association.

(Incorporated 1918.)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE
BY
THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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BRITISH STANDARD SPECIFICATION FOR

RECORDING (GRAPHIC) AMMETERS, VOLTMETERS AND WATTMETERS.

LONDON:
PUBLISHED FOR THE ASSOCIATION BY CROSBY LOCKWOOD & SON,
7, STATIONERS' HALL COURT, LUDGATE HILL, E.C. 4; AND 5, BROADWAY, LONDON, S.W.1;
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October, 1919.

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Price 1/- Net Post free 1/2.

This Specification was adopted by the Sectional Electrical Committee on 20th June, 1919, and approved on behalf of the Main Committee on 11th July, 1919

Published October, 1919.

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PREFACE.

This Specification was commenced in July, 1915, in consequence of the decision that Recording Instruments should be included in a separate Specification. It is the first British Standard Specification that has been issued for Recording Instruments, and while it is intended to secure a degree of accuracy adequate for the purposes recording instruments are usually required to serve, it must not be interpreted as signifying that, in the opinion of the Panel which prepared the proposals, recording instruments cannot be made to read within closer limits than those laid down.

C. H. WORDINGHAM,

Chairman of Sub-Committee on Electrical Accessories.

NOTE.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the article herein referred to, but does not purport to comprise all the necessary provisions of a Contract.*

BRITISH STANDARD SPECIFICATION FOR RECORDING (GRAPHIC) AMMETERS, VOLTMETERS AND WATTMETERS.

DEFINITIONS.

Instrument.

1. The term "instrument" denotes a recording ammeter, voltmeter or wattmeter, and the terms "instrument," "ammeter," "voltmeter," etc., include the recorder (as defined below) together with any accessory apparatus such as shunts, connecting wires, transformers, inductances, condensers or resistances, even if separated therefrom.

Recorder.

2. The term "recorder" denotes the instrument proper and includes essentially the means for producing the operating forces, the movement, the pointer, the chart, and the case containing them. It excludes any accessory apparatus such as shunts, transformers, condensers, inductances, or resistances, whether contained in the indicator case or otherwise.

Effective Range.

3. The term "effective range" denotes :—

(*a*) In an ammeter, voltmeter or wattmeter, the scale of which is one of nearly equal parts from zero upwards, that portion of the scale which extends down to and includes one-tenth of the maximum scale value.

(*b*) In an ammeter, voltmeter or wattmeter, the scale of which is greatly contracted in the neighbourhood of zero, that portion which extends down to and includes one-quarter of the maximum scale value, but it includes the maximum scale value, even when the higher divisions are contracted as compared with the central ones.

(*c*) In a voltmeter, the scale of which is partially suppressed, the whole range of the instrument.

Ordinary Frequency.

4. The term "ordinary frequency," for the purposes of this Specification, denotes any frequency between 25 and 100 periods per second, both inclusive.

Scale Mark.

5. The term "scale mark" denotes the line indicating the value of the quantity measured.

Scale Division.

6. The term "scale division" denotes the interval between the centres of successive scale marks.

Error in the Indication.

7. The term "error in the indication" denotes the difference of the indication referred to from the true value of the quantity of which it purports to be a measure.

STANDARDS.

British Standards of Electrical Quantities.

8. The British Standards for Electrical measurement shall be the legal Standards in the custody of the Board of Trade and all Electrical Quantities referred to in this Specification shall be measured in terms of these Standards by means of apparatus which is in agreement with such Standards at the time of use.

Standard Temperature.

9. The standard temperature for the purposes of this Specification shall be 20°C. (68°F.) unless otherwise marked on the recorder.

SPECIFICATION.

Construction.

10. The construction of the instrument shall be mechanically sound, suitable to its purpose and shall be such as to give assurance of permanence in the accuracy of the indications.

Continuous Service.

11. The instrument shall be capable of being used continuously at its maximum indication, or in the case of a wattmeter at the marked current and pressure, without injury and without the specified limits of error being exceeded.

Case or other Protection.

12. The recorder shall be contained in a suitable case, of sufficient strength to afford adequate protection against injury when reasonably used, and to exclude dust from the working parts; the accessory apparatus shall be suitably protected when necessary to ensure permanence of the accuracy of the indications. The design shall be such, that complete safety to the operator is insured when the case is open for the purpose of changing the chart or filling the pen.

Clock or Driving Mechanism.

13. Suitable means, easily accessible, shall be provided whereby the timing of the clock, or other driving mechanism, can be regulated so as not to have an error exceeding 5 minutes in 24 hours.

Identification of Terminals.

14. The terminals shall be clearly and indelibly marked, when the direction of the current between them is material, to indicate clearly the proper direction of the current through the instrument.

When a recorder is polarised, the left hand or bottom terminal, as seen from the front of the instrument, shall be the positive terminal.

Chart Ruling.

15. The scales on charts employed in conjunction with recording ammeters, voltmeters and wattmeters shall be divided into 40, 50, 60, or 75 divisions.

The value of each scale division shall be either 1, 2 or 5 of the units measured, or any decimal multiple or sub-multiple of these.

A piece of the chart shall be permanently attached to the instrument in such a position as to permit of a ready comparison between the ruling on it and the ruling on a new roll of paper.

Pointer and Pen.

16. The pointer and pen shall be insulated from the electrical circuit of the recorder.

Pen to Paper Friction.

17. Suitable means shall be provided, when necessary, whereby the pressure of the pen on the paper may be adjusted to prevent variations of pen to paper friction from introducing inaccuracy beyond the limits laid down in Clause 27.

Zero Adjustment.

18. A suitable device, easily accessible, shall be provided for adjusting the pointer to zero or other fiducial mark without risk of damage to any of the working parts of the recorder. On circuits carrying pressures exceeding 250 volts, this device shall be such that it can be employed with safety to the operator when the circuit is alive. This Clause shall only apply to spring controlled instruments.

Any instrument not complying with these conditions shall bear a warning to the effect that the adjustment shall not be made unless the instrument is entirely disconnected from the circuit.

Levelling.

19. Every recorder, the accuracy of which is affected by small changes in level, shall be provided with means of ensuring that it is in proper adjustment.

Damping.

20. The moving system of a recording instrument shall be provided with means for damping its movement suitable for the conditions in which the instrument is used. Such means shall be independent of the friction between the pen and the paper.

Insulation.

21. The instrument shall comply with the following requirements as regards insulation :—

(*a*) The insulation resistance between all the electrical circuits coupled together and the containing case, or other metal not intended to be insulated from the case when the recorder is in use, shall be not less than 5 megohms.

(*b*) The insulation resistance between the main circuit and the pressure circuit (if any) shall be not less than 2 megohms.

(*c*) The insulating material between all the electrical circuits coupled together and the case, or other metal not intended to be insulated when the recorder is in use, shall withstand, for one minute, an alternating pressure in accordance with the following table :—

Pressure above earth of the circuit for which the recorder is intended.	Test Pressure. (Alternating).
Not exceeding 25 volts ...	250 volts plus twice the working pressure of the circuit.
Exceeding 25 but not exceeding 1000 volts	500 volts plus twice the working pressure of the circuit.
Exceeding 1,000 volts ...	1,000 volts plus twice the working pressure of the circuit.

For recorders used with current or potential transformers the test pressure shall be 2,000 volts (alternating).

If the test be made with direct current the pressure shall be 50 per cent. higher than the value given in the above table.

The insulation resistance shall be measured with a pressure of not less than 200 volts nor more than 500 volts (direct), applied for a sufficient time for the reading of the insulation indicator to become practically steady.

The requirements of (*a*) and (*c*) shall apply to all auxiliary apparatus other than potential and current transformers,* used with the recorder.

Marking of Recorder.

22. The following particulars shall be indelibly and distinctly marked on the recorder in a position plainly visible from the front of the case.

(*a*) Country of origin.
(*b*) The name of the manufacturer.
(*c*) The manufacturer's serial number.
(*d*) The designation of the quantity measured.
(*e*) A distinctive special sign.†
(*f*) The temperature if differing from 20°C. (68°F.) at which the conditions as regards accuracy (Clause 27) are complied with.
(*g*) On a wattmeter, the maximum current and pressure for which the recorder is intended except when employed with transformers (*see* (*i*) and (*j*) and Clause 11).

The following additional particulars are required for alternating current instruments:—

(*h*) The frequency or the limits of frequency, if the accuracy can only be obtained at this frequency or within these limits of frequency.

(*i*) On recorders intended for use with potential transformers, the ratio of the rated primary pressure to the corresponding secondary pressure, expressed thus: 6600/110.

(*j*) On recorders intended for use with current transformers, the ratio of the rated primary current to the corresponding secondary current, expressed thus: 1000/5.

Diagram of Connections and Terminal Marking.

23. A diagram of connections shall be supplied with every recording wattmeter, which, in addition to giving the necessary information regarding the connections, shall also show:—

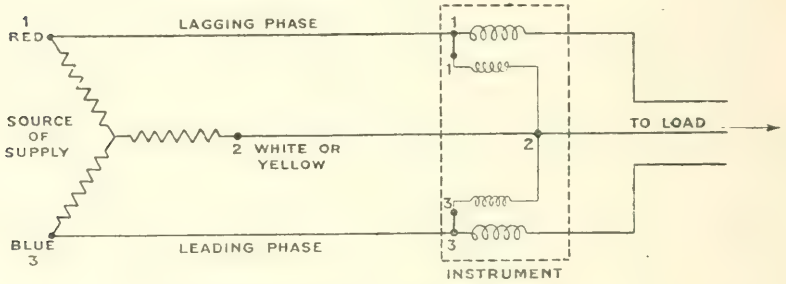
(*a*) The correct disposition of the conductors carrying current to and from the recording wattmeter, if errors would result from placing them in other than their correct position.

(*b*) For a polyphase recording wattmeter, the correct phase sequence of the supply to the windings of the recorder in accordance with the diagram.

* For the pressure test for potential and current transformers, *see* British Standard Specification for Instrument Transformers (Report No. 81) when such is issued.

† The question of marking British Standard Instruments with the Association's brand is under consideration.

For a three-phase two-element recording wattmeter the terminals shall be marked in accordance with the phase diagram, which shows the convention for connecting a two-element three-phase recording wattmeter to a three-phase network, in order to ensure that each element shall have a definite relation to the direction of phase rotation of the system.



THE PRESSURE REACHES A MAXIMUM IN THE PHASES IN THE FOLLOWING SEQUENCE:— 1, 2 & 3.

Correct Indication of Unbalanced Loads.

24. The electrical design of a polyphase recording wattmeter complying with the requirements of this specification may or may not be based on the assumption that the load is symmetrical as regards current or pressure or phase angle, but the class of load for which the recorder is suitable shall be marked thereon.

A polyphase recording wattmeter purporting to be for use on an unbalanced three-phase circuit, shall be provided with at least two current coils connected in different phases and at least two pressure coils.

A polyphase recording wattmeter purporting to be for use only on a balanced three-phase circuit need be provided with one current and one pressure coil only.

Instruction Sheet.

25. An instruction sheet shall be provided with each recorder containing particulars of the methods to be followed in erecting the instrument and the precautions to be taken which will ensure that :—

(*a*) The zero adjustment is properly made.

(*b*) The pressure of the pen on the paper is reduced to a minimum.

(*c*) The chart is attached correctly to the clock or driving mechanism.

The instruction sheet shall also draw attention to any other point which is essential to the securing of satisfactory records.

External Shunts.

26. If a shunt is neither enclosed in the same case as the recorder nor structurally a part of the recorder it shall comply with the following requirements:—

(*a*) The shunt shall have the following particulars indelibly marked either on it or on a label permanently fixed to it.

(i) The name of the manufacturer or other means by which he can be identified.

(ii) The manufacturer's serial number.

(iii) The current corresponding to the maximum scale value on the chart of the recorder with which it is intended to be used.

(*b*) No part of a shunt shall rise in temperature more than 80°C. (176°F.) above the temperature of the surrounding air, after carrying the current, corresponding to the maximum scale value of the recorder, for two hours.*

(*c*) The main terminals of the shunt shall be so constructed that slight variations in the method of connecting it to the circuit shall not alter the indication of the instrument by more than 0.25 per cent.

(*d*) The construction of the shunt and connecting leads shall be such that no thermo-electric force is produced sufficient to alter the indication of the instrument by more than 0.25 per cent.

(*e*) The drop in pressure across the terminals of a shunt to which a permanent magnet moving-coil recorder is connected shall not exceed 0.2 volt with the maximum indication on the recorder.

(*f*) The drop in pressure across the terminals of a shunt to which a recorder is connected, shall in no case exceed 1.0 volt, with the maximum indication on the recorder.

Limits of Error.

27. The error in the reading of a recorder, when tested over the effective range at the standard temperature, or at the temperature marked on it, and at ordinary frequency, or at the frequency marked on it, and, with the exception of a wattmeter, when placed in any position in a magnetic field not greatly exceeding that of the earth, and with the pen approximately half full of ink, shall not exceed the limits given in the following table. In the case of voltmeters and

* The precautions set forth in Appendix III. must be carefully observed when testing for compliance with this Clause.

wattmeters the pressure shall have been applied for 30 minutes before the test is made.

Description.	Limits of Error expressed as a percentage of the maximum scale value.
	+ or −
Voltmeter with free zero	2.5
Voltmeter with partially suppressed zero ...	1.5
Ammeter	3.0
Wattmeter	3.5

The precautions set forth in the Appendices must be carefully observed before testing recording instruments.

Variations in the Indications due to changes in the Temperature of the surrounding air.

28. The variation in the indication of a recording voltmeter due to a variation of 1°C. in the temperature of the surrounding air, expressed as a percentage of the indication, shall not exceed ± 0.3 per cent.

Variations in the Indications due to External Magnetic Fields.

29. The variation in the maximum indication of a recording ammeter or voltmeter, which is intended to be permanently fixed in any position, shall not exceed 3 per cent. of the indication when the recorder is exposed to a magnetic field of 10 c.g.s.* units in the direction which produces the maximum error in the instrument readings. For alternating current instruments, the disturbing field shall be alternating and in phase with that in the coil of the recorder.

Portable instruments not purporting to comply with the above requirements shall bear a statement of the precautions necessary to be taken to eliminate or avoid any error due to external fields.

Variations in the Indications of all Alternating Current Instruments due to changes in the Frequency.

30. The variation, at ordinary frequency (Clause 4), in the indication of a recorder over its effective range, for a departure from the marked frequency of ± 5 per cent., expressed as a percentage of the indication, shall not exceed 2 per cent.

Variations in the Indications of Wattmeters due to changes in the Power Factor.

31. The variation in the indication of a recording wattmeter over the effective range for a variation in the power factor of the load

*800 ampere turns will produce a field of approximately 10 c.g.s. units, at or near the centre of a plane circular coil 100 cm. diameter.

from unity to 0.5, expressed as a percentage of the indication, shall not exceed 3 per cent.

Variations in the Indications due to changes in the amount of Ink.

32. The variation in the indication of a recorder caused by varying the quantity of ink from pen full to pen empty shall not exceed ±3 per cent. of the maximum scale value.

Independent Tests.

33. In the event of any difference between the purchaser (or his representative) and the manufacturer as to the compliance of the instrument with this Specification, either party shall have the right to have the instrument tested by an independent authority to be mutually agreed upon by the parties, or failing agreement by the National Physical Laboratory.

Should the purchaser or manufacturer require that any or all instruments, under a contract, be tested by an independent authority before acceptance, such requirement should form part of the contract.

APPENDIX I.

Accuracy of different types of Recorders.—The following table serves to indicate the type of recording ammeter, voltmeter and wattmeter, which will give the accuracy mentioned in this Specification :—

Type.	Conditions
Permanent magnet moving-coil ...	On direct current.
Moving-iron ...	On alternating current at or about a given frequency.
Dynamometer ...	On direct current or alternating current at ordinary frequency.

APPENDIX II.

Chart Speed.—The speed of movement of the chart of any recorder should be such as to secure in combination with the damping arrangements a clear record. In arriving at the paper speed, due consideration must be given to the fluctuations of the quantity it is desired to record, together with the rapidity with which these fluctuations occur. If the fluctuations are periodic or follow one another closely, the chart speed should be such that the chart will move at least the breadth of the ink record between successive lines drawn by the pen.

APPENDIX III.

Erecting Shunts.—A shunt dissipates the heat generated when current is passing more by conduction than by radiation. It is, therefore, necessary to ensure that the ends of the shunts and any bars to which the shunts are connected are of such section and area as to permit of good contact being made, and thus to prevent any rise in temperature due to insufficient section or bad contact.

When a shunt is built up of a number of sheets, the greatest cooling is obtained when it is erected horizontally with the sheets in a vertical plane, so as to permit the greatest amount of ventilation between the sheets.

If by reason of the design of the switchboard it is necessary to erect the shunt with its terminals one above the other the lower end of the shunt should be connected to the positive pole.

When the shunt ends consist of flat connecting plates machined either on one or both surfaces, it is essential to ensure that the whole of the surfaces are in contact with the bars to which connection is to be made in order that the lines of flow of current shall be not unduly distorted.

British Engineering Standards Association.

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OCTOBER, 1919.

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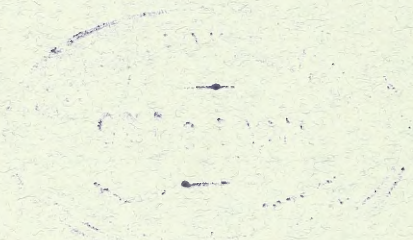
Printed by
Waterlow & Sons Limited, 49, Parliament Street, Westminster,
S.W. 1.